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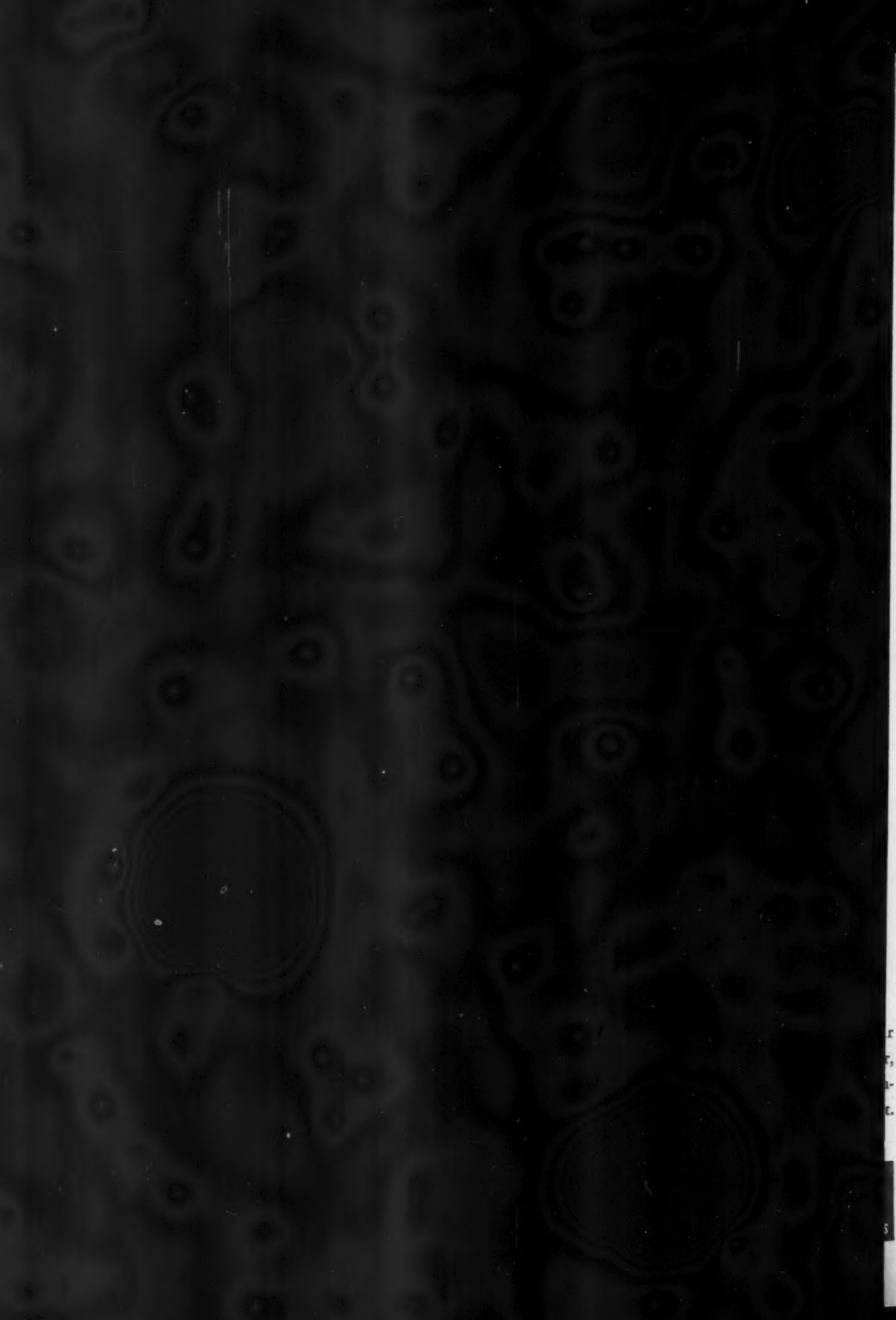

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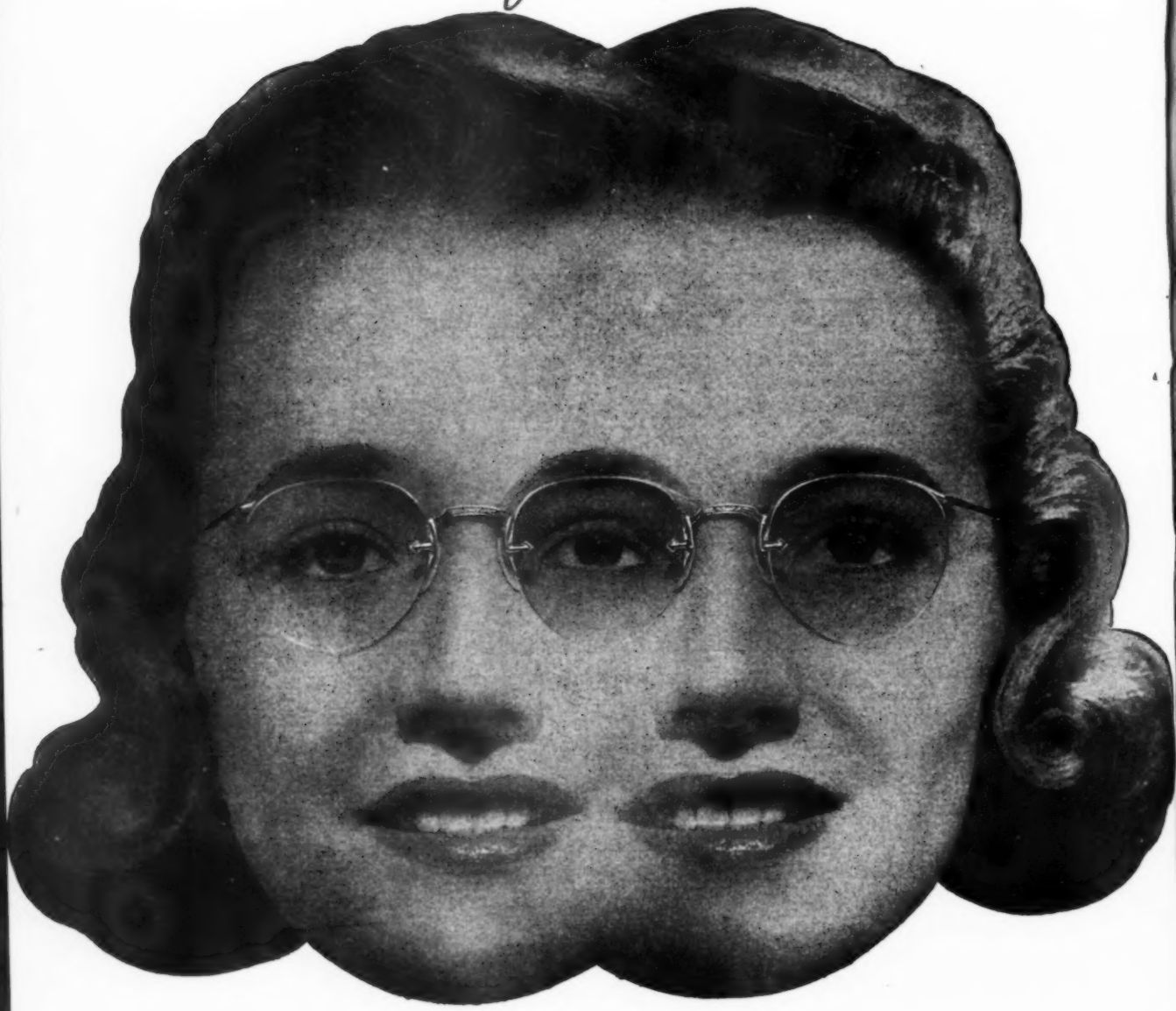

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A METHOD FOR THE CORRECTION OF ANOMALOUS CORRESPONDENCE*

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Philadelphia, Pa.

INTRODUCTION

For some years the treatment of strabismus has been a problem of gross proportions. This is due to the many variations and types of strabismus which are encountered clinically. Numerous papers have been written on the etiology, classification and treatment of squint, but at present it can scarcely be said that the number of successfully treated cases from the standpoint of orthoptics is high enough to be satisfactory. In The Clinics of the Pennsylvania State College of Optometry where the incidence of strabismic cases is quite high, an attempt to solve some of the existing problems in the correction of squint was begun. It is the purpose of this paper to present an introductory report on a method of treatment for the correction of strabismus when anomalous correspondence is present. In order to be consistent in this work only one clinical type of squint was selected for treatment, namely the convergent concomitant squint of "tonic" variety with a probable accommodative etiology.

Diagnosis of the type and amount of squint will be considered first. When, with a squint present, the movements of either eye are unrestricted in all meridians, (normal rotations) and when, with the eyes unoccluded, the angle of the squint remains approximately the same for fixation in all meridians then it is considered as being non-paralytic or concomitant. A brightly illuminated object is often necessary to elicit full rotations since the visual acuity of either eye may be very low and the external rotators of the eye are frequently asthenic—rather than paralytic.

*Submitted on March 21, 1941, for publication in the October, 1941, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

Tonic squint has been defined as that type resulting from an abnormal reciprocal innervation to the extra-ocular muscles. It may be the result of one or more of many different conditions, for example, asymmetrical distribution of the retinal elements, a congenital lack of any fusion faculty, an imbalance to avoid fusion as in aniseikonia or cyclophoria, or lastly a continual heterotropia resulting from refractive errors. We will be concerned with those tonic squints caused by the last factor only.

The etiology of accommodative squint is of interest to our problem. Between the ages of 18 months and four years, in the interest of clear vision, the eyes begin to make use of accommodative power. Individuals at that age are commonly hyperopic and may be anisometropic. Since the fusion faculty has not been refined at these early ages, if the hyperopia is inordinately high and if the anisometropia is enough to cause a markedly unequal visual acuity, then the eyes may become esotropic, especially after a physical or psychic trauma or after illness such as croup, the exanthemata, diphtheria, etc. The squint may develop slowly, however, being at first periodic or present only during near fixation. Accommodative squints result from the partial or limited interdependence of convergence and accommodation because, regardless of the immediate cause, correction of the refractive error establishes orthotropia.

If the squint is uncorrected, then gradually, suppression of macular vision of the squinting eye occurs. Macular fusion is unlearned (if ever existent) and in its place an anomalous correspondence is learned and the squint finally becomes one of the tonic variety, in which full correction of the entire refractive error now no longer fully corrects the squint.

It is important that the squint be accurately diagnosed, both qualitatively and quantitatively. The test for concomitancy has been described. Concomitant tonic squint with an accommodative etiology may be unilateral or alternating in deviation. In unilateral squint, one eye usually fixes, there is a monocular dominance, and amblyopia and suppression of the other eye is usually present. The objective cover test for squint is a diagnostic method of importance. When applying the cover test, care must be taken to allow the eyes to assume their usual position between each occlusion. The patient should be instructed to look up, down and then to close the eyes between each test.

THE QUANTITATIVE TESTS FOR ANOMALOUS CORRESPONDENCE

It is of utmost importance that the esotropia and the anomalous

correspondence be accurately measured. Since there is faulty projection in many cases, we cannot consider any subjective measure of the angle of the squint as being valid. An uncomplicated yet accurate objective method of measurement follows:

After using the cover test to ascertain which is the fixing eye, the patient is instructed to look directly at the zero point of a perimeter. With the subject's face illuminated to decrease the pupillary aperture, the other eye being occluded, the image of a retinoscope or ophthalmoscope light is centered in the pupil of the fixing eye by moving the light laterally around the inside of the perimeter and the number of degrees is recorded. Thus it is evident that angle kappa has the visual axis as

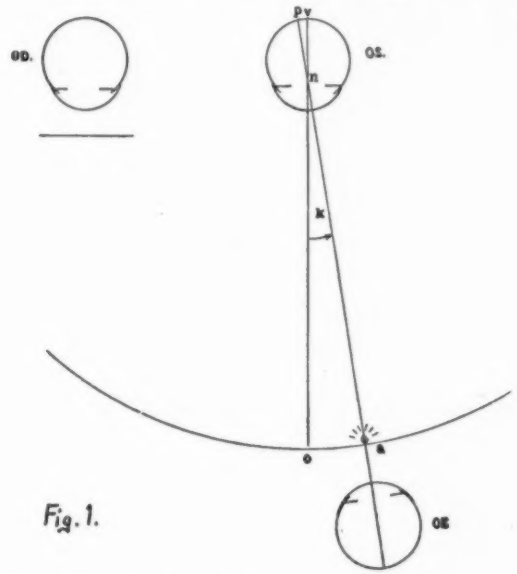

Fig. 1. The measurement of angle kappa. k, angle kappa; OE, examiner's eye; o, zero point of perimeter; vo, visual axis; pa, pupillary axis; n, nodal point; l, light source.

one side, the pupillary axis (a line passing perpendicularly through the center of the pupil) as the other side and the vertex at the nodal point.

The angle will be measured accurately (within $\pm 1°$ error by experienced observers) only when the center of the pupil, the corneal reflex, the small light source and the observer's eye are on the same axis as illustrated in figure 1.

Angle kappa is measured in the fixing eye for the following two reasons: (1) Unless the visual acuity of the squinting eye is very good,

the chances of perfect central fixation are slight. (2) There may be monocular fixation with the paramacular area. For our measurement of squint, it will be assumed that the angles kappa of the two eyes are equal, which assumption has been consistently verified at The Clinics of the Pennsylvania State College of Optometry. The interpupillary distance is then measured accurately with the visual axes in their primary position.

The sighting system (ss, Figure 2) is now placed laterally to the zero mark on the carrier (cc) designed for this purpose at a distance equal

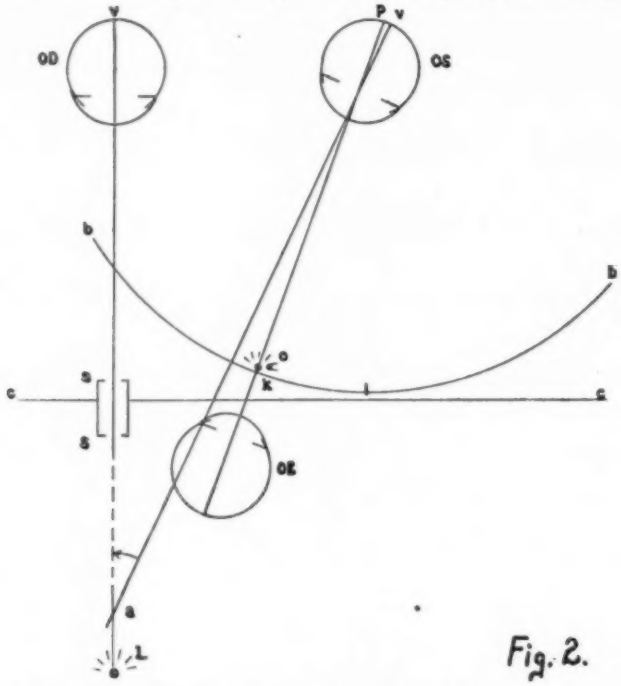

Fig. 2. The measurement of the squint. OD, fixing eye; OS, squinting eye; OE, observer's eye; vav, angle of squint; o, observer's light; l, fixation light; va, visual axes; pk, pupillary axis; bb, perimeter; ss, sighting system; cc, carrier for sighting system.

to the interpupillary distance. It is positioned to the right in convergent squint of the left eye, as illustrated. The patient is then placed facing the perimeter so that a distant light source (1) is viewed with the fixing eye through the sighting system. As can be seen by the illustration, the squinting eye is now positioned directly in front of the zero point of the perimeter.

With the patient fixing the distant light (1) the observer's light

(o) is again moved within the arc of the perimeter until the corneal image is centered in the pupil of the squinting eye and the number of degrees recorded. This recording is the measurement of the angle formed by the visual axis of the fixing eye and the projected pupillary axis of the squinting eye. Adding the value of angle kappa to the first recording equals the angle of squint, i.e., that angle formed by the visual axis of each eye.

Now, if the pupillary axis is found to pass through the zero point of the perimeter, then we know that a squint exists equal in amount to angle kappa. This is so since, were there no heterotropia present, we would find the pupillary axis as many degrees temporal for the eye not fixing the distant light as was found for the eye first measured.

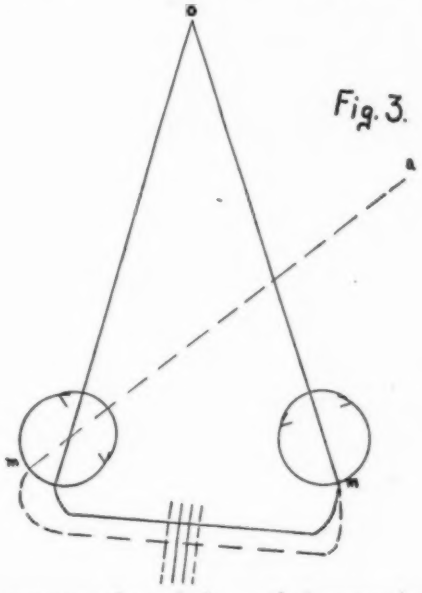

Fig. 3. Schematic representation of the cortical connections and the ocular projection in anomalous correspondence. m, maculae; ma and mo, visual axes; o, fixation point.

Few of these cases have diplopia and furthermore almost all of the cases exhibit a superimpositional power and even a rudimentary fusion faculty. However, while the eyes are still in a squinting position if superimposition is evidenced without prism power base-out before the eyes exactly equal in deviating power to the objective measurement of the squint, then it is evident that the two maculae are no longer associated, rather the macula of the fixing eye is now associated with an extra-

macular area in the squinting eye. The anomalous correspondence is therefore equal in prism diopters to the difference of the objective measurement in degrees (multiplied by 1.7) and the amount of prism diopters base-out at which superimposition is effected.

THE ETIOLOGY OF ANOMALOUS CORRESPONDENCE

If an accommodative squint goes uncorrected for any considerable length of time, then, as stated previously, complete refractive correction does not establish orthotropia. The squint, being present at all times results in an extramacular area of the squinting eye receiving the same impression as the macula of the fixing eye. During the development of the squint this area was probably suppressed to avoid diplopia but later it became associated with the macula of the fixing eye, superimposition of the images thereby taking place. (See figure 3.) Were this learned association not so, then superimposition of similar retinal images could not be obtained without prism effect base-out equal to the objective measurement of the squint, which superimposition can be exhibited with prism power other than that which should correct the squint.

If foveal vision exists in the squinting eye, then no movement of the eyes will be observed when the maculae are stimulated with similar objects alternately, i.e. with prism power base-out equal to the objective measurement of the squint before the eyes. This technique is a method of aligning the foveae and in many cases corresponds to the objective measurement of the squint and gives added information about the anomalous correspondence.

TREATMENT OF ANOMALOUS CORRESPONDENCE

The longer the convergent squint is present, the more firmly established does the association of the macular image of one eye and the extramacular image of the other eye become. If, with any suitable orthoptic instrument, the squinting eye is stimulated by flashes to improve visual acuity with only enough prism power in front of the two eyes to give superimposition (not necessarily macular superimposition) then the anomalous correspondence becomes more firmly entrenched in the visual perceptive center and the squint is made more permanent. With this erroneous treatment, the visual acuity of the squinting eye may improve but will be limited by the anatomical characteristics of the extramacular area.

Occlusion of the non-squinting eye has been advocated and is used extensively to treat "amblyopia exanopsia" and the convergent squint.

If, by the cover test, it can be demonstrated that the macula exclusively fixes when the non-squinting eye is occluded, then occlusion may improve visual acuity of the squinting eye. However, if macular fixation does not occur with occlusion of the non-squinting eye, then the extreme amblyopia makes occlusion a difficult procedure and the patient's cooperation is poor. Even if this objection is overcome, vision remains at a very low level since anatomically, vision cannot be greatly improved for a peripheral retinal area, as pointed out previously. The need for binocular macular visual education of the two eyes is thus made evident.

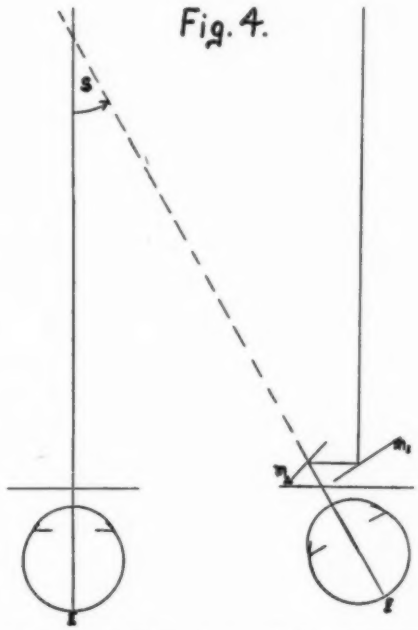

Fig. 4. Double mirror reflection at an angle corresponding to the squint. f, foveae; m_1 and m_2, mirrors; S, angle of squint.

The maculae of the two eyes must be stimulated simultaneously, which may be done on a suitable orthoptic instrument by having the correct amount of base-out prism power before the eyes equal to the objective measurement of the squint. To increase the stimulus value of the target before the squinting eye, the illumination must be brighter than that before the fixing eye and may be flashed on and off. The subject should be instructed to watch the dimly lit object continually and to try to make out as much detail as possible of the diplopic image which is a macular image, but "seen out of the corner of the eye".

By this treatment, proper binocular projection is encouraged. However, such treatment can be practically applied at the most only about three hours per week. The rest of the time, the anomalous correspondence is instituted more firmly, as the patient, when away from the instrument unlearns that which he has been taught. Thus it seems that the only effective method of treatment is a continual one.

Prisms base-out equal to the objective measurement of the squint would be one acceptable treatment. However, the prisms of power enough to deviate the two images to the two maculae, produce either distortion (if flat) or size difference i.e. artificial aniseikonia (if curved); they accentuate the chromatic aberration inherent in all spectacle lenses; and they offer mechanical difficulties due to their weight. Nevertheless, if prescribed correctly for squint cases of less than about 15 prism diopters, then continual stimulation of the two maculae, anatomically suited for optimum binocular vision, should aid squint cases having anomalous correspondence.

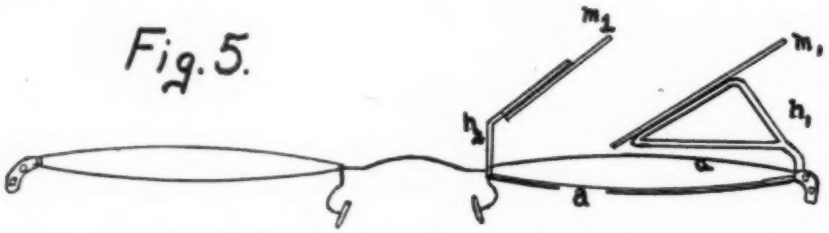

Fig. 5. Cross-section of the mirror spectacle device. m_1 and m_2, mirrors; h_1 and h_2, holders; a, aperture.

Continual stimulation of the maculae can be effected by another method. If two small mirrors are mounted in front of the squinting eye and are inclined with each other to produce a deviation of the incident light equal to the angle of squint, then the image falls on the macular area and both maculae are stimulated simultaneously.

In constructing the mirror spectacle it is helpful to first draw on paper the optical considerations involved in each case, and then to build the device from this pattern. One mirror (m_1 fig. 4.) will be angled 45° from the plane of the lenses and the other (m_2) will be angled 45° less one half the angle of squint. The mirrors m_1 and m_2 measuring about 25 mm. and 16 mm. square respectively, are mounted on small metal plates which have been attached to the frame by wire structure work. (Fig. 5.) The ametropic correction is placed in the frame and blackened

out except for an aperture through which the reflected light enters the eye. The size and position of the aperture will vary with the angle of squint, and the separation and size of the mirrors. The field of view through the mirrors will be an average of about 15°. Depending on the facial characteristics, the field of view for squints over 30° may be too small to be practical.

When the device shown in figure 5 is worn the patient usually will report heteronymous diplopia. This is due to the faulty spatial projection of the images on the anomalously corresponding maculae when both are stimulated simultaneously. If the amblyopia in the squinting eye is of proportions preventing diplopia, the use of a smoked lens before the good eye may be of value in an effort to equalize the vision of the two eyes.

CONCLUSIONS

Almost all cases of convergent concomitant squint which were previously accommodative have an anomalous correspondence or abnormal retinal projection. It is important that the eyes be carefully and fully corrected refractively and that the squint be accurately qualitatively and quantitatively diagnosed.

The anomalous correspondence should be measured and then treated by binocular macular stimulation. This can be accomplished in the office for a limited time with any suitable orthoptic instrument. Continual simultaneous binocular macular stimulation can be practically obtained with a mirror device which can be varied to treat the amount of squint.

This is a preliminary report on the rationale of such treatment and a description of the device.

In 1933 a patent was assigned to Dartmouth College, Hanover, N. H., for a mirror spectacle device. This spectacle consisted of a somewhat similar arrangement in which the angling of the mirrors was such as to produce a tortion of the image about the visual axis. The purpose of this device is solely limited to the optical correction of cyclophoria.

The mirror spectacle for the correction of anomalous correspondence differs from the Dartmouth spectacle in that no correction for cyclophoria is ever attempted; that the plane of the mirrors is such that the image is not rotated about the visual axis; and that the purpose is to deflect images in anomalous correspondence to anatomically corresponding points of the retina.

THE AFTER-EFFECT INDUCED BY VERTICAL DIVERGENCE*

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In measuring the tolerance of prism base-up or base-down to the break point, Bielschowsky[1] and others have reported that maintaining the eyes in a position of vertical divergence long enough to make the measurement so affects the eyes that they do not return immediately to their normal resting position when they are dissociated.

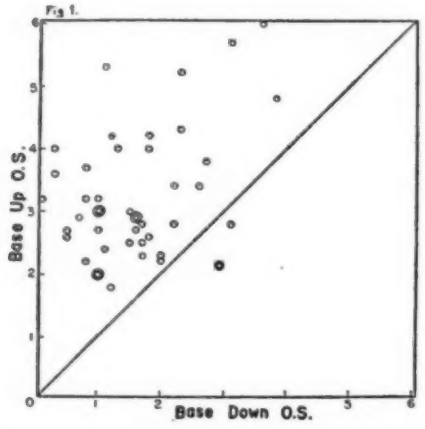

Figure 1. Correlation of the base-up and base-down O.S. break point findings. Concentric circles indicate two cases falling at the same point.

In a routine examination the vertical phoria finding is taken before the base-up or base-down ductions and consequently the vertical phoria

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[1] A. Bielschowsky, Lectures on Motor Anomalies, Dartmouth College Publications, 1939, p. 12.

is not affected by the disturbance which follows a supra and infraduction measurement. However, it is customary to take a series of supra and infraduction measurements in succession and it is therefore essential to know to what extent one vertical duction measurement will affect a second duction measurement immediately following. The following sequence of tests was used;

Vertical phoria at 40 cms.
Vertical ductions at 40 cms.

Base-up	O.S.	to break and recovery
Base-down	O.S.	to break and recovery
Base-up	O.D.	to break and recovery
Base-down	O.D.	to break and recovery

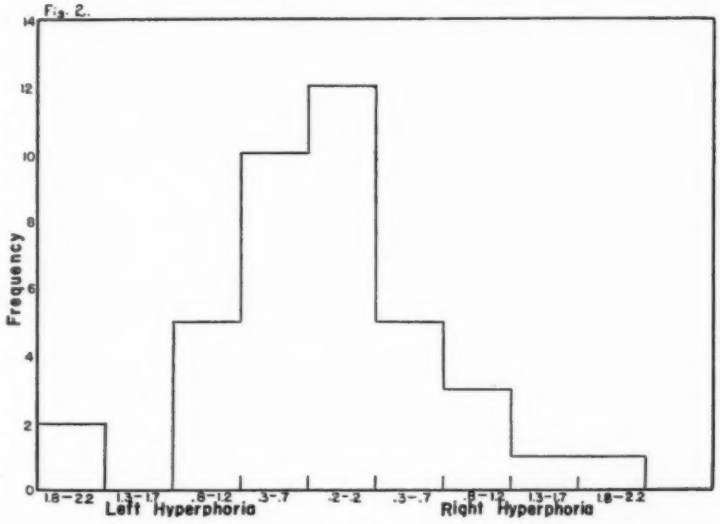

Figure 2. Frequency distribution of the phoria findings taken immediately before the duction sequence.

The instrument used to perform these tests was an *American Optical Company* additive phoropter, with two rotary prisms giving a maximum of 15Δ for each eye. The highest degree of accuracy was exercised in lining up the centers of the two pupils with the centers of the lens cells when the phoropter was level. If the subject wore a correction its equivalent was inserted in the phoropter.

The fixation chart to determine the vertical phoria and ductions consisted of a single row of 20/30 letters. The illumination of this test

card was held as constant as possible by means of a 40 watt bulb 18 inches from the test card.

In determining the break point, the subject was instructed to report when he first noticed the breaking of the line of letters. The recovery was measured by having the subject report immediately when the two images fused into one. The time for a complete sequence of the duction tests (O.D. or O.S., as outlined above) seldom exceeded 1 minute.

In the sequence the B.D.O.S. duction test followed the B.U.O.S. tests and consequently maintaining the eyes in a position of positive vertical divergence during the B.U.O.S. test should tend to reduce the B.D.O.S. break point finding. This effect is actually demonstrated in

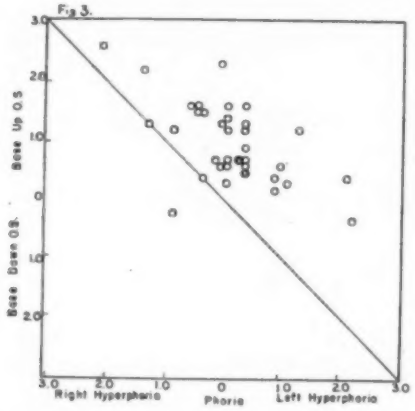

Figure 3. Correlation of the phoria findings with the midpoint of the range between the base-down and the base-up O.S. break point findings.

the scatter diagram in Fig. 1 in which the B.U.O.S. break point findings are plotted against the B.D.O.S. break point findings. The results show a considerable tendency for the base-up findings to be higher than the base-down findings. This cannot be explained on the ground that there is a general tendency toward right hyperphoria, because no such tendency is evident in the frequency distribution (Fig. 2) of the vertical phoria findings made at the beginning of the sequence of tests.

It is true however that there is some relationship between the vertical phoria findings and the base-up and base-down ductions as is shown by the scatter diagram in Fig. 3 in which the middle point of the range between the base-up to break and base-down to break is plotted against the phoria. In general the center of the break point range shifts in accord-

ance with the hyperphoria measurement. The graph also shows a tendency for the middle of the break point range to be shifted in the direction of base-up O.S. from the phoria position. This is further substantiation that the base-down break point finding is lowered when it is preceded by the base-up duction test.

In performing the before mentioned sequence of duction tests, the eyes were first forced into a position of maximum positive vertical divergence (base-up O.S.) and then into a maximum negative vertical divergence position (base-down O.S.) The base-up O.D. break was then measured, which again forced the eyes into a maximum negative vertical divergent position. This in turn, was followed by the base-down O.D. break test, which forced the eyes into a maximum positive vertical divergent position.

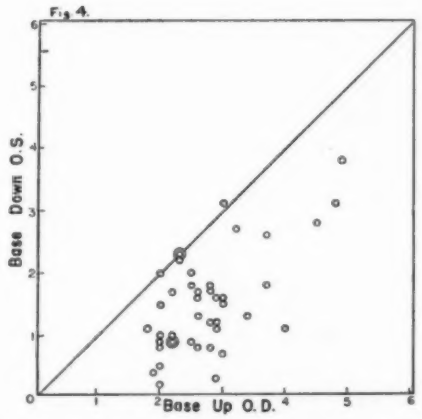

Figure 4. Correlation of the base-up O.D. and the base-down O.S. break point findings.

Although the base-down O.S., and the base-up O.D. break tests both forced the eyes to use maximum negative vertical divergence to maintain binocular fixation to the break point they were not equal. This is shown in graph 4, in which the base-up O.D. break findings are considerably larger than the base-down O.S. findings. This indicates that the base-down O.S. break test was obviously affected by the disturbance set up by the B.U.O.S. test, and helped to neutralize this disturbance, so that the succeeding test was not affected. The B.U.O.S. test might have even created a shift toward right hyperphoria which would have augmented the B.D.O.D. finding.

Since the base-up O.D. break test was followed by the base-down

O.D. test; (i.e., a test requiring negative vertical divergence was followed by a test requiring positive vertical divergence) it might be expected that the B.D.O.D. findings would be lowered because of the disturbance set up by the B.U.O.D. test. Graph 5 illustrates this effect. The base-up O.D. finding is definitely the greater in a very large percentage of the cases.

These results illustrate that the disturbance which is set up by a supra or infraduction test does not subside immediately after its completion, and that one duction test will very definitely affect a second duction test which is made immediately afterward. Consequently, the time interval between the measurements of ductions has to be taken into considera-

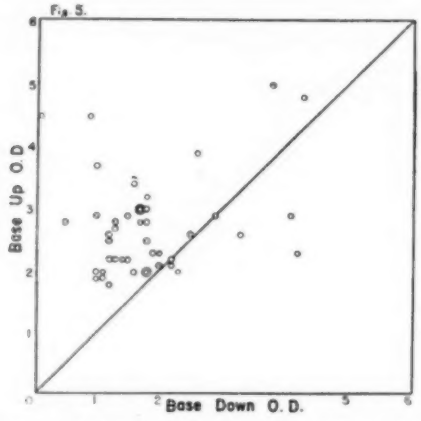

Figure 5. Correlation of the base-down O.D. and the base-up O.D. break point findings.

tion if an accurate measure of both O.D. supra and infraduction are desired.

Likewise these results indicate that if an individual has a vertical phoria, the best procedure would be to measure the compensating duction prior to the opposite duction. For example: in a case of right hyperphoria, it is more important to get a true measure of right infravergence than of right supravergence.

Appreciation is expressed to the *Univis Lens Company* for a Fellowship which has made possible the Senior authors' contribution to the present work.

COLOR RELATIVITY: THE RELATIVITY OF PSYCHOLOGICAL AND PHYSICAL COLOR TERMS*

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Humanity, it seems, tends to treat a truth which is established to its satisfaction as being singular, with complete disregard for its infinite plurality in a relativity sense. At the same time, paradoxically enough, it may accept the relativity tenet which states that a truth which has a single definition in a certain empirical reference frame, may at the same time be as plural in definition as there are different reference frames to give it plurality. The theories and practices of color vision and color harmony owe much of the apparent conflict between the views of psychology and physics to the fact that the relativity of such authentic empirical and theoretical data seem to be little understood.

The main objective of this theory of color relativity is to institute an effort directed toward unifying the definitions of terminologies employed in reference to color. A deeper understanding of the relativity of terms will be sought. Definitions for color terms will be postulated, which are not in conflict with those viewpoints of the particular physics reference frames involved.

Color psychologists, productive of such brilliant efforts as the Birren system of color dimensions as an example, recognize that psychology is perhaps the most empirical of studies. Yet in spite of the factual responsibilities of such super-behaviorism, the clarifying assistance of the empirical findings of the biophysicist are lost because the laboratory physics terminology is unacceptable in the light of the experience of psychology. The empirical nature of psychology, however, should certainly demand that the correlated experiences of biophysics be made available as basic knowledge of color harmony, as well as color vision.

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The principle of relativity in color terms, here postulated, can hurdle this barrier of laboratory-spectrum terminology by recognizing the different relativity frames involved.

The definition of the term black offers an important and convenient starting point. The psychologist observes that the addition of black to a hue alters the visual response to the hue in a positive manner. Yet, because the spectroscope can reveal no wavelength to the physicist for its definition, it is assumed that psychology must consider its definition of black as inconsistent with that of physics. Actually, valuable confirmation may be obtained by a unified understanding of the biophysical findings about black.

The biophysicist knows that black pigment is a sponge for all visible hues of light and combination of hues. Thus, if the chemical pigment black is added to a pigment hue, it reduces the amplitude, or volume, of the visual response to the hue. This is done by reducing the total volume of reflected light. The biophysicist also knows that in some cases the reduction in amplitude is accompanied by a change in cerebral response, or psychological vision, of the original hue. This occurs with such psychologically secondary color hues as orange. A physical empiricism explaining this reaction will be gone into later in this paper, substantiating and not opposing the acceptance of this fact by psychology.

The psychological experiment of mixing black with a hue by the mechanical means of a color disc, is in direct correlation to the visual threshold experimentation of the biophysicist. The physicist finds the result to be explainable in terms of the reduced light stimulation of the retinal cones and rods over a given threshold period of recognition. Thus every interruption of the reflected hue, by the black disc, reduces the total amplitude of the hue response in the time period minimum for cortical recognition. This is definitely a positive effect of the presence of black as observed by the psychologist, yet an empirical fact of physics when viewed in its proper relativity.

The laboratory physicist, inasmuch as he must shoulder the basic burdens of the atomic physics of the chemist as well as those of the spectroscopist, knows black in terms of a still different relativity. It is true that he doesn't see it in the spectroscope, because it is not a light ray. Perfect black, never observed by the spectroscopist, would be a pigment capable of absorbing 100 per cent of all incident light, with a subsequent reflective factor of zero. Empirical laboratory experience, how-

ever, has shown the physicist that there are various chemical structures which achieve the atomic physics necessary to absorb those visible light hues above the amplitude threshold of the human eye. In this respect, therefore, the physicist empirically knows that the addition of black pigment to a reflective color effects a positive change in the visual response to the color and that the reduction in response amplitude is sometimes accompanied by a psychological change in the resultant cortical recognition. This change in the nature of the cortical recognition of a mixed, or secondary hue in the visual sense, when the total amplitude of the stimulus has been reduced by the addition of black pigment, is common to both the experience of the biophysicist and the psychologist. The only confliction present is the terminology-definition usage of black, without due consideration for the relativity involved in its particular usage.

To state, therefore, that black is negative in physics and positive in psychology, is sheer sophistry. The relativity involved transcends such apparently diametrically opposed definitions of black as positive, or negative.

The spectroscopic physicist, for example, finds black negative with respect to wavelength and positive with respect to indication of absorption lines which he attributes to interference. The biophysicist finds black very positive with respect to visual response due to light absorption and very negative in respect to visual response due to reflection. The many elaborations of this point are obvious as well as numerous. The irrationality of maintaining conflicting definitions of the same terminology is clearly indicated and the need most apparent for a definition qualified by its relativity requirements.

The term black is therefore given the following relativity definition without offending either the usage of psychology or physics.

Term:	*Relativity Definition*:
Black.	The reduction in amplitude of response to light stimulus.
100 Per Cent Black.	100 per cent reduction in response to light stimulus.

Such statements of psychological recognition as, "The night is black", would therefore have to be restated as, "The night is dark", in order to be consistent with the relativity definition given above. The positive vision of a black object, as observed by the psychologist, will consist of a visual response amplitude that is in the inverse ratio to its

percentage of blackness. A 100 per cent black object, if you could obtain it, would show no detail except outline against a visual background. This is obviously true and to call it positive vision is to lose all understanding of the relativity involved. If a 100 per cent black object could give positive vision it could be identified by a light beam directed upon it in a 100 per cent black room, whereas it is empirically known that if the light beam falls solely upon the object and is shielded from the eyes of the observer, no visional response is obtained.

The statement, so often encountered in color literature, that positive psychological vision of an object is always present if a contrasting visual background is present, is purely a limited statement of an implied viewpoint of specific relativity. Excluding the term black from this psychological usage avoids an obvious and useless truism.

It is a rational, but not always cogent fact, that the classification of a negative identification must involve a positive relativity in order to justify such a classification. This involvement, however, can be avoided by the usage of the given relativity definition of black and the expansion of any general statement involving black to include its implications.

For example the statement given above would be expanded to the following, if it included the vision of a black object. Positive, or *negative* vision of an object is always present if a contrasting visual background is present.

Another apparent confusion in the psychological and physical usage of the term black occurs in discussing the colors that contain black as a component and do not appear in the physicist's spectroscope. Brown is such a hue and is known to physics as the result of certain biophysical mechanics of the eye that are entirely consistent with the psychological recognition of this hue as such. The confusion arises from the relativity of the stimulus source to the psychological recognition mechanism.

If the stimulus source is of a single wavelength, the addition of black pigment to a reflecting body would not produce a hue that is psychologically recognizable as brown. If the stimulus source is productive of a brown hue it is, consequentially, formed of more than one dominant wavelength. Viewed in its proper relativity the fact that the psychologically identical orange of pure wavelength and mixed wavelengths, produces brown in one instance and not in the other when mixed with black, is not paradoxical.

The retinal cones of the human eye, which constitutes those nerve

endings capable of response to color stimulus and hue definition, have a sensitivity which varies with the wavelength of the light stimulus. In addition to this variance in retinal response amplitude the psychological recognition of hue usually has at least one more effective factor involved. This additional factor is the distribution of energy present in the source of the light stimulus.

It will be noted that noon sunlight, considered very desirable for proper color vision, has a nearly uniform distribution of energy throughout the visible spectrum. The conventional electric light, with a tungsten filament, is shown to have an extremely uneven distribution of energy. It is here contended that a consideration of the relativity factors indicated in figure 1 will clarify many of the paradoxical color terminology definitions used by psychology which seem diametrically opposed to the extant concepts of physics.

For example, two hues may be observed as having different psychological recognition values, or response values, whereas a biophysical empiricism concludes that the two hues have equal retinal response values. Orange and green are but two such hues which have occasioned this type of difficulty in terminology definition. If the light source is a tungsten filamented electric light, with more light of orange wavelength present than of green wavelength, it is axiomatic that an orange hue reflector will achieve a greater psychological response than will a green reflector because of the greater available orange stimulus to be reflected. This in no way conflicts with the biophysical fact that wavelength pure orange and green light hues of the same stimulus energy values result in retinal and psychological responses of the same value.

Another important factor is involved in the relativity of conditions present in the psychological recognition of orange and green, if the stimuli are of heterogeneous composition. Both psychology and biophysics offer empirical proof that a singular and identical cortical recognition of a given hue may result from either a pure wavelength stimulus or a heterogeneous stimulus. If the recognized hue stimulus is of heterogeneous composition and the hue is a visual primary, like green, the hue identification is a function of the dominant wavelength present. In the case of orange, which is not a visual primary, the actual orange wavelength of the spectrum may be either dominant, subordinate, or missing entirely from the composite stimulus. It is empirically found that the hue psychologically identified as orange, may result from any of the following stimulus compositions: Red, yellow and green wavelengths; red and

green wavelengths; red, yellow, green and orange wavelengths; red, green and orange wavelengths.

Thus the relativity of the particular hue, the nature of the stimulus composition and the retinal sensitivity to the wavelengths present may be additive to the distribution of energy present in the light source producing the eventual psychological response value. The complex requirements of any color terminology definition that seeks complete justice to the subject can only be meagerly indicated by the simplified surface conditions here suggested in orange and green hue recognition. The complexity of possible relativity factors which might effect the final psychological-cortical recognition of color hues, force the definitions postulated in this paper to seek the following solution to the general problem of terminology: It will be the endeavor to avoid inconsistency with possible factors, rather than seeking strictly localized consistency with arbitrarily set conditions which are so often assumed by both physics and psychology.

The psychological recognition of brown as a hue derived from orange to which black has been added, is obviously defined by the specific relativity involved in the functions of each component forming this particular brown response. Such a brown hue is here postulated as being the result of the separate functions of the different response-thresholds related to each dominant wavelength present in the heterogeneously composed orange to which black has been added. The complex orange hue stimulus would obviously be altered in regard to its cortical recognition by the addition of black which reduces the total amplitude of each dominant wavelength component. Those components having the lowest retinal response, as the addition of black reduces them toward their visual threshold energy values, act to alter their emphasis in the combined hue stimulus and so alter the cortical recognition of the combined stimulus. If the orange stimulus were of only one dominant wavelength the addition of black could only reduce its retinal response and the cortical recognition would not be altered, it would only be reduced in value. Brown, consequently, could not appear as the result of adding black to a monochromatic orange with its single dominant wavelength.

The term white, as well as black, has been the subject of much debate and conflict in terminology definition. An allocation of certain factors present in the relativity of white vision and the stimuli productive of it, will serve to indicate the requirements of a desirable definition.

Psychology recognizes the positive change in the value of visual response to a hue, to which white has been added. It is here postulated that the addition of white pigment to a specific pigment-hue results in the dilution of the cortical response to the specific hue. The dilution of the specific hue cortical response is a function of the reduced proportionality of the specific hue stimulus in relation to the total retinal stimulation.

The addition of white to a specific hue stimulus by means of mechanical disk mixing, reduces the proportion of specific hue stimulus present on the retinal cone during its minimum recognition threshold time. It is postulated that this mechanical mixture of white thus acts as a diluent to the cortical response value of the specific hue stimulus.

In the vision of an additive light mixture containing light of a specific hue and white appearing light, the white light acts as a diluent to the specific hue by reducing its proportionality in the total stimulus.

To the spectral physicist, pure white is considered to be light with an even and continuous distribution of energy throughout the entire visible spectrum.

The biophysicist considers pure white vision as arising from light with its energy so distributed that it evenly stimulates all specific hue response mechanisms of the retina.

The pure white of psychological recognition is a positively identified hue arising from a cortical response to a stimulus empirically proven to be of a heterogeneous composition.

The following relativity definition of the term white is offered as being amenable to all specific and general usages of the term, yet capable of further specificity for any desired fixed reference frame.

Term:	*Relativity Definition*:
White.	An effectively complete hue aggregate, diluting specific hue identity beyond distinction.

It has been shown that the psychological usage of the terms black and white are not in confliction with the definitions extant in physics, but are merely related to different co-ordinates. It cannot be too strongly stressed that all such apparently contradictory definitions of terms of proven rationality should be definitely amenable if viewed in their proper relativity. It is not necessary, for example, to relinquish the con-

ception of color as defined by hue, value and chroma if one desires to define it by hue, black and white. Such an impasse becomes less than ephemeral if the relativity of the terms is considered. It has been already stated that it is the contention of this paper that all man's known truths are as plural in definition as there are differing relativity conditions to give plurality. Any one truth, to be completely singular in definition, would have to be absolute and transcendental of specific relativity frames.

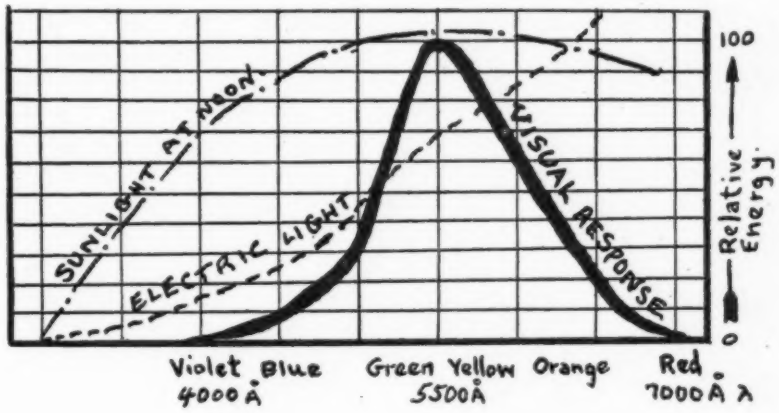
Consider two observers, "A" and "B", who have empirically proven themselves to be responsive to color in the same measure and to have identical psychological recognition standards. With an identical comparison chart of hues for each, "A" and "B" take different positions to view a small colored objective. The light stimulus coming from the objective is composed of a combination of known and calibrated wavelengths. "A" views the object from a distance of only a foot or so, while "B" views it from a distance of seven or eight feet. Observer "A" finds the recognized hue to be different than observer "B". Here is an apparent confliction in the definition of the psychological recognition resulting from a given stimulus of calibrated composition. Yet the relativity involved shows two differing physical conditions involved and therefore no paradox in the differing cortical recognitions of observers "A" and "B". Obviously the stimulus from the objective has fallen upon a large area of observer "A's" retinal cones, whereas observer "B" receives the stimulus in only his foveal area. In the instance of observer "B", the image stimulus has passed through the macula lutea, the slightly yellow membrane which lies over the fovea. Thus a portion of the stimulus has been absorbed before it reached the cone nerve ends and observer "B" received a different psychological recognition response than observer "A". Thus the two definitions of observers "A" and "B" were purely functions of the relative conditions involved and not contradictory.

In defining a single color, either the response is psychologically recognized, or the stimulus is calibrated as to composition. The result identifies the hue with respect to either psychological or physical co-ordinates, or both. The integration of these attributes need not result in the same identification, although they cannot be contradictory inasmuch as they each refer to different reference frames. Once the hue is identified it is further qualified by two additional co-ordinates, much as a musical tone is first identified by tone, then volume and timbre. It is here contended that these two hue-qualifying co-ordinates which are termed value

and chroma, by the physicist, are capable of a relativity definition that is also applicable to the black and white termed co-ordinates often preferred by the psychologist.

The value, or response amplitudes, of color hues vary with the wavelength of the stimuli, as shown in figure 1. This statement assumes that the relative conditions present are such that these value gradients are not distorted, however. Obviously, one cannot discuss an amplitude variance between two musical tones, for example, in the presence of a third tone so loud that the amplitude variance loses meaning. In a like manner, one cannot speak of the value of a spectral pure, monochromatic

Figure 1.



yellow as indicative of the amplitude of response to a heterogeneously composed yellow with its wider distribution of energy.

With the relative conditions considered, however, it is safe to assign a given value to each hue of a given stimulus volume. It is understood, of course, that the relative considerations mentioned refer to broad enough value assignments to incorporate any individual and inherent response values which might be present in a heterogeneous stimulus which is productive of the single hue response. Thus the value of a hue which has already been positively identified must act as a qualification of the condition of the stimulus and its response, rather than as a contribution to its identification as a hue. Thus if an identified hue is of a lower value than is consistent with its energy origin and its wavelength, it is indicative that a response-reducing factor is present.

It is therefore postulated that the value co-ordinate of a positively

identified hue must refer to the black content present in order that it have any functional meaning.

The chroma, or saturation, of a positively identified hue is the third co-ordinate to be considered. In order to have any functional meaning this co-ordinate must refer to some degree of hue saturation below maximum. Inasmuch as dilution would seem to be the complement of saturation, it is suggested that this term has a more functionally positive meaning than saturation.

It is thus postulated that the chroma co-ordinate of a positively identified hue must refer to the white content present, in order for it to have any functional meaning.

The theory of color relativity has, at this point, correlated the methods mentioned of hue identification and dimension used in physics, with those used in psychology. To sum up:

Term:	*Relativity definition*	*Psychological usage*	*Physics usage*
Visual HUE	Response recognition	Cortical recognition	Retinal response
Stimulus HUE	Dominant stimulus	Retinal stimulus	Dominant wavelength
Recognized hue			
VALUE	Response amplitude	Black content	Brightness
Recognized hue			
CHROMA	Hue dilution	White content	Hue saturation
Term:	*Relativity definition*	*Psychological usage*	*Physics usage*
BLACK	The reduction in amplitude of response to light stimulus.	Positive cortical response to amplitude reduction.	Light absorption, throughout the visible spectrum.
WHITE	An effectively complete hue aggregate, diluting specific hue identity beyond distinction.	Positive cortical response to a sufficiently general retinal stimulus.	Light of even energy distribution throughout the visible spectrum.

It is felt that enough specific emphasis has been put upon term relativity to indicate something of the co-ordination required to clear up the many ambiguities to be found in the general subject of color terminology. It is the contention of this paper that if a plurality of definitions exist for any single term and if these definitions are each philosophically sound and empirically authenticated, then an understanding of the relativity involved precludes any possibility of confliction. It is further contended that intelligent progress, in view of this, must require an attitude of flexibility upon the part of researchers in color who confine themselves to any specific relativity framework of reference.

REPORT OF TWO CASES IN WHICH THE RETRACTION SYNDROME WAS MANIFESTED*

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According to Whitnall,[1] deficiencies and abnormalities of the extra-ocular muscles are not rare occurrences. The probable reason why such conditions go unrecognized is the difficulty in differentiating some of these, from actual paralytic types of strabismus. Not all abnormal conditions have groups of symptoms or syndromes which may serve, at least as diagnostic aids, to establish such differentiation.

On the basis of his experiences in the dissecting room, Whitnall arrived at the conclusion that these muscular deficiencies and abnormalities arise from improper development and cleavage from the common premuscular mesoblastic mass. This observation is shared by Mann[2] and by Peter[3].

According to Mann[2] the four recti and two oblique muscles separate from their common mesodermal cone, which surrounds the back of the globe at the 20mm stage. The levator superioris muscle is not present at this stage but arises soon thereafter by separating from the medial border of the superior rectus muscle. Therefore, should the superior rectus muscle fail to develop, the levator muscle also will be absent.

Abnormal development and deficiencies of ocular muscles are not confined to one single muscle. As a matter of fact any one or more than one muscle may be thus affected. Casten[4] reported two cases of congenital absence of the inferior rectus muscle. Duane[5] described the retraction syndrome (to which his name has been given) in cases of congenital absence of the external rectus muscle, in the following words: "Another less frequent congenital deviation occurs as a syndrome in which the external rectus is nearly or quite paralyzed, the internal rectus is paretic,

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and the eye when turned inward retracts more or less strongly into the orbit and at the same time turns up (sometimes down) while the palpebral fissure closes (false ptosis)." Many other authorities (here unmentioned) have written at length on ocular palsies and ophthalmoplegias, in which congenital anomalies of the ocular muscles were found to be the causative factors.

Cases of congenital paralysis of all the extra-ocular muscles have also been reported in ophthalmic literature. In many instances these conditions are found to be due to congenital deficiencies and abnormal development of one or more than one muscle. The existing abnormalities may be found as complete absence of a muscle; or there may be fibrous tissue instead, devoid of contractility and other functions common to ocular muscles.

TWO CLINIC CASES

I have recently seen in clinic two cases in which the Retraction Syndrome was manifested. In one case it was the left eye only that was affected, in the other the condition was bilateral.

Case No. 1

R. Y. age 6 came to the clinic on February 15, 1941. The child has been wearing glasses for several years, the last examination having been concluded several days previously, at which time was prescribed:

O.D. +4.00 D.Sph. ⊂+0.50 Cyl. axis 30

O.S. +3.50 D.Sph. ⊂+3.00 Cyl. axis 150

The child had left convergent strabismus of about 25° with a periodic

right esotropia alternating, especially noticeable when she was tired or ill.

Upon examination it was observed that the left eye was not capable of outward movement. Instead, it maintained a fixed position. But when the right eye was made to move outward, the left turned inward and upward (See figure one). The eyeball retracted and there was partial ptosis, which really was more in the form of winking than actual partial closure of the lid. It was impossible to determine accurately the visual acuity of each eye. The visual tests that were made, however, indicated that it was fair in the left and good in the right eye. Co-ordination aptitude tests indicated alternating fixation and no fusion. A tentative diagnosis of congenital absence of the Left External Rectus muscle was made.

Case No. 2

V. M. age 12 has been wearing O.U. +1.00 D. Sph. for some time which was found adequate during the examination on February 8, 1941. This patient was found to have no external outward movement with the right or left eye. The right palpebral fissure widened on looking forward, but on looking nasalward, it closed and there was bulbar retraction (anophthalmos). The left eye showed the same manifestations, and in addition, it was noticed that when that eye turned downward, the left lid closed entirely; while there was only partial closing of the right lid. (See figure Two). Co-ordination aptitude tests were made in this case also and found to be lacking. A tentative diagnosis of congenital absence of the external recti muscles of both eyes was made in this case. The possibility of congenital anomaly of the right superior rectus muscle was not entirely eliminated.

Observations: These two cases and a study of other writings on the subject bring to mind the following observations: (1) Congenital abnormalities of the extra-ocular muscles are not as rare as is believed. (2) It is difficult to establish differential diagnosis between paralysis and the congenital absence of a muscle, merely by observation. Operative investigation offers the only definite means. (3) The only corrective procedure for congenital anomalies of the extra-ocular muscles is surgical. Orthoptic treatment is of no avail.

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EXPENDITURES FOR MEDICAL AND OCULAR CARE

A Consumer Purchase Study of family expenditures for medical care has been conducted in small cities, villages and on farms. This was a W.P.A. project made under the supervision of the Bureau of Home Economics of the United States Department of Agriculture[1]. Five regions were selected for spot surveys in this undertaking. These were in New England, Middle Atlantic and North Central, Plains and Mountain, Pacific, and Southeast areas. These surveys were made during 1936 although the report of their findings was not published until this year.

On the assumption that the health of the population is a matter of

[1] Family Expenditures for Medical Care. Consumer Purchases Study. Miscellaneous Publication No. 402. U. S. Department of Agriculture. Washington, D. C. 1941.

national concern, it follows therefore that family expenditures for medical care are also a matter of concern and efforts were made to determine from families interviewed during this survey the amount annually spent for medical care.

Classed as medical care were services such as those of physicians, surgeons, and other special practitioners (including midwives, chiropractors, and healers), nurses, dentists, and oculists; hospital care, medical tests, special examinations, blood counts, X-rays, medicines, drugs, medical supplies, and eyeglasses. Payments for health and accident insurance were also included in the totals.

Data were compiled not only on the total amount spent for medical care by income groups, but also by classifications as to what phase or type of medical care was purchased.

The survey included data from families having an annual income of from $250 to $3,999. These families were divided into ten groups for purposes of statistical study which included a breakdown of the amounts spent annually for various health services for each group.

The data developed by this survey indicate that the portion of aggregate income devoted to all forms of medical care by families within the income range $250—$3,999, varied from 3.7 to 5.2 per cent, following no consistent pattern, and that families in the lower income levels receive but little care annually.

For example, at the income level $250—$499, average medical care expenditures were $17. At the level $500—$749, average expenditures were $33. At the level $750—$999, average expenditures were $36. At the level $1,000—$1,249, average expenditures were $47, while at the income level $1,250—$1,499, the average expenditure for medical care was $61. The total average for the 3,042 families of all income levels in this portion of the report showed an annual average expenditure of but $58 for all medical care.

The data also indicate that of the total amount spent for all forms of medical care, only 6.1 per cent was spent for all forms of ocular care. Of this 6.1 per cent spent for ocular care a study of the data reveals that 1.4 per cent was spent for services rendered by oculists and that 4.7 per cent was spent for services rendered by optometrists.

As these studies were made only in small cities, villages and in farming areas it is reasonable to assume that but little of the 6.1 per cent

shown, was spent for the services of retail dispensing opticians as none of these are in business in the small urban centers studied.

The data also indicate that of the total number of families investigated, that 24.9 per cent had had some ocular care performed during the past year. Of this total of 24.9 per cent, a further study of the data reveals that 6.2 per cent of all families consulted oculists while 18.7 per cent of all families consulted optometrists. In other words, 25 per cent of those families having ocular care during the period covered by the survey consulted oculists while 75 per cent consulted optometrists.

It is also reasonable to assume that the term oculist used in this study covers such medical men as would be found doing ocular work in the smaller centers, these being a few ophthalmologists, somewhat more eye, ear, nose and throat men and a number of general medical practitioners who do some refracting.

Lines of demarcation between some of the different items of medical care are also not clearly defined and this fact must be taken into account in interpreting data concerning the composition of total ocular costs. For example, most oculists in small cities do their own dispensing of optical materials, just as do the optometrists in similar small cities. Family reports of totals paid for ocular services to oculists, no doubt include payments made to oculists for glasses dispensed by them. There may have been confusion, too, in the minds of some persons interviewed as to whether ocular services were performed by optometrists or oculists as the outward appearances of many practices are similar.

Reverting to the percentages of the total amount spent for all medical care, we find that medical expenditures are grouped in this study as follows:

Physicians general medical care	31.9 per cent
Dental care	15.7 per cent
Hospital room or bed	12.2 per cent
Health and accident insurance	10.5 per cent
Medicines and drugs	8.4 per cent
Surgical care	8.0 per cent
Ocular care and eyeglasses	6.1 per cent
Nursing service	2.6 per cent
Special examinations and tests	1.8 per cent
Medical appliances	1.0 per cent
Clinic visits	0.7 per cent
Other health care	1.0 per cent

The figures present nothing particularly new or startling. They verify much already suspected as to the distribution of health costs and

indicate that persons in the lowest income levels are without question going without certain professional services which would probably be helpful to them. A vast amount of statistical data are included in this study and report, and much of this material will no doubt be used at a later date by the proponents of certain forms of state-wide public health programs for the indigent and that large block of our citizens who are now termed medically indigent.

From an ocular standpoint this governmental survey indicates that slightly more than three-fourths of the ocular work performed for citizens, who live in the smaller urban centers, villages and on farms, is being done by optometrists, a fact already accepted by the optometric profession and now merely verified.

To us as optometrists the future is clear. First, it is not how much ocular work we do that really counts. What is of vital importance is, how well we do this work. And second, we must face the inescapable fact that our professional plans must now be laid to give proper refractive care to a very large block of citizens who cannot now afford to pay the usual fees asked for our services.

Carel C. Koch.

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

by J. Fred Andreae, Secretary

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

PRESENTING SPEAKERS WHO WILL APPEAR AT THE ANNUAL MEETING OF THE ACADEMY

In this issue, as in the last, we are again presenting a few of the speakers who will appear before the Academy at its annual meeting at the Morrison Hotel, Chicago, December 7, 8 and 9.

Dr. Glenn A. Fry, Dr. Robert Bannon and Dr. Lewis H. Kraskin are all well known in ocular circles and their presence as speakers will

add much of interest to these important sessions. Every member of the Academy owes it to himself and his profession to attend these meetings.

DR. GLENN A. FRY

Dr. Glenn Ansel Fry has been Assistant Professor of Physiological Optics, in charge, at the School of Optometry, Ohio State University since 1935. He received his A. B. from Davidson College in 1929, his M. A. from Duke University in 1931 and from the same University his Ph. D. in 1932.

DR. GLENN A. FRY

From 1932 to 1934 he was a National Research Fellow at Washington University School of Medicine. At the same school in 1934 and 1935 he was Research Assistant in Opthalmology.

He is a well known lecturer and student of research. Since becoming a member of the American Academy of Optometry in 1937, he has been on the program yearly.

DR. ROBERT BANNON

Dr. Robert Bannon is one of the younger men in Optometry, of whom we can well be proud. After previous education in engineering, and the pre-medical course at Fordham University, he graduated in Optometry from Columbia University in 1934.

In the fall of 1934 Dr. Bannon became associated with Dr. Franklin A. Seward, optometrist, Empire State Bldg., New York. While there, through Dr. Harold M. Fisher, optometrist and iseikonic clinician at the N. Y. Eye and Ear Infirmary, he became interested in aniseikonia. Consequently, in October of 1935, Dr. Bannon became affiliated with the Darthmouth Eye Institute, Hanover, New Hampshire. At present he is Clinical Fellow in Physiological Optics and is a member of the faculty of Dartmouth College and Dartmouth Medical School.

Dr. Bannon has published a number of papers dealing with the clinical aspects of aniseikonia which have appeared in this journal and

others. He has also collaborated on other papers prepared by staff members of the Dartmouth Eye Institute. In December, 1940, he prepared a 700 ft. movie on the "Technique of Measuring Aniseikonia," and exhibited it to the Academy at its annual session.

Dr. Bannon has lectured frequently throughout the country on the subject of aniseikonia and is well known to optometrists generally. He is a member of the New Hampshire Optometric Association, the American Optometric Association, the American Academy of Optometry, Dartmouth Scientific Association, New Hampshire Scientific Association and the American Association for the Advancement of Science.

DR. LEWIS H. KRASKIN

DR. LEWIS H. KRASKIN

After graduating in optometry Dr. Kraskin continued his education in the Graduate Schools of George Washington University and the American University of Washington, D. C., majoring in Psychology. He is a Research Fellow of the American Academy of Optometry on the problem of Emotional Disorders and their Affect on Vision.

A writer of innumerable papers on this and other scientific subjects, Dr. Kraskin has lectured before optometric, medical, dental and lay groups. Academy members are well aware of his work from lectures and writings in optometric publications.

He is a member of the Educational Committee of the International Association of the Boards of Examiners in Optometry, a member of the Board of Standards for Public Health Service of the American Optometric Association, and president of the District of Columbia Board of Examiners. This is in addition to being an active member of the Biological Society, the Philosophical Society, the American Association for the Advancement of Science and other scientific societies.

In the November issue of this journal we will present additional speakers who will appear before the Academy at its 1941 meeting, as well as a complete program covering the three day sessions.

BOOK NOTICES AND REVIEWS

Books received are acknowledged by notices in this department. Special selections will be made for more extensive review in the interest of our readers as space permits.

THE DIAGNOSIS AND ELIMINATION OF VISUAL HANDICAPS PREVENTING EFFICIENT READING. George A. Parkins, D.O.S., F.D.S.F.O., F.A.A.O. Director of the American Research Council of Optometry. Published by the Distinguished Service Foundation of Optometry, 56 North Main Street, Fall River, Mass. 142 pages. Illustrated. Cloth. 1941.

This slim volume by the director of the American Research Council of Optometry is of much greater importance to practitioners engaged in near point refraction than its size might indicate. It contains the results of a series of surveys and case studies carried on over a period of approximately eight years with groups of school and college students, and some individual cases taken from private practice. In the conduct of some of the group studies the author was assisted by Dr. H. B. Peters, a research fellow of the Council.

In this treatise Dr. Parkins attempts to analyze the chief factors obstructing reading efficiency, including speed comprehension and ocular comfort, and his findings seem to indicate rather conclusively that an adequate fixation ability is the basic skill required. This, indeed, appears to be of even greater importance among pre-presbyopes than the correction of substantial refractive errors, which so many practitioners have always assumed to be most essential for near point efficiency. In tests of over 700 students, for example, he found that over fifty per cent of those handicapped in obtaining academic knowledge were deficient in fixation ability as against only seventeen per cent from impaired visual acuity.

He also cites evidence that this all-important fixation skill is apparently an acquired rather than an inherent accomplishment, thus readily lending itself to improvement by orthoptic methods.

The Opthalmograph is mentioned as a helpful instrument in detecting and recording eye movements by the photographic method, and was freely employed throughout his cases, although a simple observational technic is also described for satisfactory results. Investigation among grade and high school students revealed that a fixation disparity

greater than 1△ is a definite handicap in reading speed. Breadth of eye span and rapidity of visual perception and coordinated eye movements are additional visual skills mentioned as essential to near point work.

The importance of properly balanced reciprocal innervation to the end of efficient eye movements in reading is stressed, and the author is of the opinion that central suppression areas frequently represent a skill developed to compensate for a defective fixation ability. He warns against the breaking down of such suppressions by binocular exercises until after the fixation ability has been adequately established.

A detailed description of his orthoptic procedure is outlined, in which he employs an instrument called the Binocular Synchronizer, the use of which is restricted to supporting fellows of the American Research Council. This is supplemented by the use of a modified Squint Korrector and Tele-Eye-Trainer, but inasmuch as the Synchronizer constitutes the major instrumentation, it is to be regretted that it has to be restricted to members of the Council only.

He concludes with an amply documented series of cases from his own private practice.

This meaty, yet readable, book is worthy of study by all practitioners interested in the problems of near point efficiency, and outlines a field of corrective work admirably adapted to the Optometric profession.

Arthur B. Emmes

CONTACT LENS TECHNIQUE. L. L. Beacher. Second Edition. Published by the author at 33 West 42nd St., New York City. 113 pages, 32 illustrations. Cloth, $3.50. 1941.

In his own way, Beacher tells the practical story of prescribing and making contact lenses. This is not a theoretical text. Its general application towards the subject is purely clinical and the author presents his material on the basis of a step-by-step review of the subject. The book is well illustrated and Beacher throughout talks contact lenses in words of one syllable.

Carel C. Koch

YOU'RE ONLY YOUNG TWICE. Doree Smedley. Published by Simon and Schuster, N. Y., 1941. 354 pages. $2.00. (One chapter, "Do You Need Glasses?" reviewed.)

"Today there are more than 30,000 eyesight specialists in the

United States, equipped with the most modern instruments."

"The need of glasses does not necessarily herald advancing age."

"Your eyes should be examined every year from childhood on; after twenty, every two years; after forty, as often as your eyesight specialist requests."

This is a book written for women over thirty. By a housekeeper and magazine writer after one year of questing among beauty experts, dress designers, stylists, etc., for the answer to woman's ever-present question, "Can anything be done for me, to improve my appearance?" Chapter 16 is so full of excellent advice on visual care as a beauty aid that we suggest it should be on every optometrist's list of *must* books for the reception room. Optometric organizations could very well encourage the sale of this book. Russell E. Simpson

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PROCEDURE AND INSTRUMENTATION

by Guy L. DuPlessis

A department wherein discussions will be carried on relative to the value of various experimental and clinical techniques as employed by practicing optometrists, and also in which the instruments used by optometrists in various phases of their work, will be subjected to some critical evaluation.

A NEW TEST FOR THE DETECTION OF COLOR BLINDNESS

When a person fixates a colored object for a 30 to 60 second interval by daylight illumination, and then shifts his gaze to a neutral background, he will perceive a more or less evanescent form, of a size equal to the object, but of a complementary color. If red is the color of the fixation object, the after-image will be blue-green; if green, the complementary color will be magenta-red; turquoise-blue for yellow, etc.

This color phenomenon of after-images is utilized by P. B. Wiltberger, M.D., as a test for color blindness. He deduces that the absence of color perception will result in the absence of a colored after-image, and to go further, that a defective color sense will be evidenced by an alteration of the complementary image from the normal. He bases the validity of this test on his color theory that color vision is a physico-chemical process whereby the cones are in a state of chemical balance when no color is seen; upon seeing a color a state of imbalance sets in almost

instantaneously and when the color is removed, a reversal process begins. This reversal process is what gives rise to the complementary after-image which disappears when the reversal process is completed and normal balance is achieved.

Color blindness, in his estimation, is an inability to perform this reaction and reversal due to a defect in the receptor mechanism.

Dr. Wiltberger criticizes the Ishihara and Stilling tests as not being true tests of color blindness, but "pastel tests" not to be relied upon. Because these tests are tests of color intensities, he claims that many who are normal except for a color "weakness" see both the normal and the color blind numbers on the plates. The Wiltberger test[1] is said to eliminate this objection because it is not a confusion test as are the others. However, it seems to the writer that this test cannot serve to estimate degrees of color defect.

Because the intensity of the after-image varies inversely with the intensity of the stimulus, the test is made of light colored paper oblongs pasted on a grey background. On the opposite page are complementary colored paper oblongs placed vertically so that the horizontal after-image of the color observed will form a cross with the vertical test oblong. Thus the patient need not know the name of the color but identifies it by matching the after-image with one of the three colors seen on the right side of the form.

If the test is valid, it seems to the writer that it is one of absolute color blindness for any one color and as such is more rapid than the Ishihara and Stilling tests, but it can hardly be used for a quantitative evaluation of a color defect other than a total defect.

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[1]A New Test for the Detection of Color Blindness. P. B. Wiltberger, M.D. Published by the College Book Company, 1836 North High St., Columbus, Ohio. Board covers, $8.00. 1941.

ABSTRACTS

A department in which will appear abstracts of the literature of optometry, ophthalmology and applied optics. These will be classified according to the following list, although contributions to all sections will not necessarily appear in each issue.

1. Ocular Refraction.
2. Physiological Optics and Color Vision.
3. Ocular Muscles.
4. Orthoptics and Reading.
5. Anatomy, Histology and Embryology.
6. Ocular and General Pathology.
7. Ophthalmic Lenses and Material.
8. Instruments.
9. Hygiene and Illumination.
10. Applied and Physical Optics.
11. Education, Sociology and Economics.
12. Miscellaneous.

1. OCULAR REFRACTION

STATIC RETINOSCOPY. Bind, Edward. Canadian Optometrist. 1941, 3, 1, 16-22.

Bind reviews in considerable detail the exact techniques to be followed in making static skiametric examination according to the procedure outlined and suggested by the Optometric Extension Program. He then presents the method of interpreting these static findings as secured by using the foregoing techniques. The article closes with a comparison of the static skiametric techniques and refractive values of Sheard and those of Pascal with those of the Optometric Extension Program leaders. —C.C.K.

ANISEIKONIA, Boeder, Paul. Optometric Weekly, 1941, 32, 19, 530-532.

A 1.5 per cent size difference in retinal images is sufficient to cause trouble. In a grouping of 3,000 cases who had their aniseikonia corrected some 65 per cent reported some relief from their symptoms. In this short review of the subject Boeder concludes (1) the correction of aniseikonia must be regarded as one of the important factors if efficient binocular vision is to be maintained, and (2) a clinical investigation for aniseikonia should be made in all cases of functional disturbances of the eyes, especially when the correction of refractive errors and heterophoria has failed to give relief.—C.C.K.

RE-EXAMINATION OF THE HIGH AMETROPE. Swann, L. A. Optician (London), 1941, C1, 2616, 219.

In making a re-examination of a patient who has a large amount of ametropia, Swann suggests the use of the following subjective technique to further verify the findings of the completed new refraction. The patient is instructed to put on his old glasses of which there is now

some question as to their correctness of power. One eye is then occluded with an occluding disc which is hung from the lenses or frame. Trial case lenses of such combined power to, with the old correction, equal the tentative new formula are then held before the spectacle lens while the patient views objects at a great distance through an open window. The same procedure is then followed with the other eye. Improved distance visual acuity is frequently accomplished by minor changes made in the total formula by means of this technique, according to Swann.—C.C.K.

SOME THOUGHTS ON MYOPIA. Marton, H. B., Refractionist (London), 1941, 30, 521, 89-95.

Marton reviews the most accepted as well as the more unique theories as to the cause of myopia. The author expresses no opinion as to his value of these theories.—C.C.K.

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2. PHYSIOLOGICAL OPTICS AND COLOR VISION.

AN EXAMINATION OF STEREOPSIS. Scott, H. A., Dioptric Review and British Journal of Physiologic Optics (London), 1941, 2, 1, 3-20.

Scott reviews the subject of stereopsis and suggests that a standard test be provided to establish a true "normal." As stereopsis depends upon the binocular factors of convergence and binocular parallax, Scott suggests also that the required test condition could best be met by using a stereogram with fixation at 13 inches. Such a stereogram should be made in a form which would allow of a "fluid" measurement of stereoscopic acuity, and Scott suggests that this be accomplished by having a fixed pair of targets and a second pair, one on a right and one on a left handed screw thread so that by rotation of a knob they could approach nearer to or be further separated from each other at will. Under this arrangement a change of separation of the movable targets of 0.1 mm. would represent a change in the parallactic angle of 1 minute. According to Scott, the ideal mechanical stereogram would be made after the manner of an engineer's micrometer, and would be thus capable of giving the fine measurements required. The advantage of this fluid form of measurement over the fixed form of stereogram would be similar to the advantage of the risley type of prism over the loose prism and with the fluid form

the examiner can take a reading at the precise point of significance. Scott suggests the micrometer scale on his proposed stereogram be calibrated to give a direct reading of the parallactic angle in minutes and seconds of arc.—C.C.K.

THE MEASUREMENT OF HETEROPHORIA. Cridland, N., British Journal of Ophthalmology, 1941, 25, 141-167.

Cridland extensively reviews the literature of the past seventy years on the subject of heterophoria and summarizes the conclusions reached, as follows: (1) There are four positions of rest of the eyes; each is the result of additional factors operating upon its predecessor. (1) The anatomical position of rest is the resultant of all anatomical and non-nervous physiological factors and, in the absence of secondary pathological changes, it is, invariably, divergence. (3) In the physiological position of rest is added the effect of minimal, balanced tonus of all the extraocular muscles. It is closely akin to the anatomical position of rest. (4) The physiological position of rest is changed into the fusion-free position by the addition of the effects of the postural and fixation reflexes. (5) The functional primary direction is visual parallelism. (6) According to the test employed, and the care given to the ancillary conditions, the position of rest revealed by any test for heterophoria may be the fusion-free position, or some position intermediate between this and the physiological position of rest, or any perversion of either of these. The physiological position of rest is not obtained by any practicable test yet devised. (7) Basic heterophoria is the latent tendency of the eyes in vision at infinity to deviate from the functional primary direction, in the presence of actual or effective emmetropia. (8) The criteria of efficiency of a test for heterophoria depend on the position of rest which it is desired to obtain. Since, for most practical purposes, the fusion-free position is required, the fusion reflex is to be excluded, and the postural and fixation reflexes are to be stimulated in such ways only as will not cause a false deviation of the visual axes. (9) There are many means of so stimulating the postural or fixation reflexes or both as to cause a deviation which initiates the measurement of a heterophoria. The majority of tests are open to damaging criticism on these grounds. (10) The wearing of glasses for a test is insufficient, for they must have been worn previously for long enough to have re-established a normal accommodation-convergence ratio. With this precaution the use of a cyclopegic is unnecessary. (11) The deviation must be given time to develop; gen-

erally speaking, enough time has been given when two successive measurements are the same. (12) The range of variations of the deviation can, with care, be made small enough to render a single measurement significant.—R. J. B.

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3. OCULAR MUSCLES.

MUSCLE BALANCE DETERMINATIONS AT THE READING DISTANCE. Maxwell, J. T., Archives of Ophthalmology, 1941 (July) 26, 98-101.

This paper contains a brief review of some of the physiologic laws involved in ocular convergence for purposes of offering constructive criticism of some prevalent methods employed by ophthalmologists in determining ocular efficiency at the reading distance. The topics touched upon are: The relation of accommodation to convergence, exophoria for near vision, accommodative and proximal convergence, and the near point of convergence.—R. J. B.

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4. ORTHOPTICS AND READING.

CONDUCT OF AN ORTHOPTIC CLINIC. Tassman, I. S., The Eye, Ear, Nose and Throat Monthly, 1941, 20, 210-214.

The conduct of an orthoptic clinic is described with reference to its general plan and purpose. Equipment, facilities, organization and routine procedure are discussed.—R. J. B.

THE EFFECTS OF MONOCULAR VISION ON MEASURES OF READING EFFICIENCY AND PERCEPTUAL SPAN. Knehr, C. A., Journal of Experimental Psychology, 1941, 29, 133-154.

This study compared, on a group of 16 normal adult subjects, the effects of reading with monocular and binocular vision on eye movement measures of reading efficiency for short lengths of material. Correlative data were obtained in the form of perceptual spans for monocular and binocular vision on material similar to that used in reading. A span for non-meaningful material was also determined by means of the decreasing accuracy of seeing a standard test object moved right and left of the fixation to a distance of approximately 3 degrees. The main conclusions are as follows: (1) No evidence was obtained to support the

hypothesis that reading efficiency should increase when binocular fusion is dispensed with (i.e., in monocular vision). Monocular reading time, fixation frequency, and regression frequency did not differ significantly from the binocular. (2) Perceptual spans for monocular vision showed a significant decrease of ten per cent as compared to binocular perceptual spans. (3) No increase in the number of fixations proportional to the decrease in perceptual span was noted for monocular reading. (4) The vergence movements noted in binocular eye movement records retain their characteristic form and approximate magnitude in monocular reading. Changes in vergence are attributed to changes in accommodation. (5) Considered as a whole, the data provided further evidence that reading efficiency depends largely upon the individual's familiarity with words as symbols and his store of ideas and meanings.—R. J. B.

STRABISMUS. SOME CONCLUSIONS AND EXPERIMENT. Gibson, H. W., British Journal of Physiological Optics, 1941 (May), 44-56.

Single binocular vision is achieved through the projection of two separately elaborated cerebral images projected through one common path as a single sensation. This common path is produced through the motor function of convergence which directs the visual axes so that they intersect at the point of regard.

The function of convergence receives its innervation through two cerebral centers, (a) the frontal centers under the direct control of the will of the individual and (b) the occipital centers activated mainly as a reflex action of single binocular fixation. The two components of the function have been termed voluntary and involuntary convergence respectively.

Concomitant strabismus would therefore appear to be due to a defect in, or non-development of, the motor function of convergence which is the basic movement of single binocular vision.

Observation on cases of divergent concomitant strabismus show that the innervation from frontal centers and occipital centers are necessary for the achievement of single binocular vision in correct proportion and that the maintenance of single binocular vision through every meridian of the visual field cannot be achieved by voluntary convergence alone.

Orthoptic treatment for the correction of concomitant strabismus must therefore consist of:

1. Correction of refractive errors.
2. Elimination of amblyopia and neutralization.
3. Correction of abnormal projection and abnormal retinal correspondence.
4. Development of single binocular fixation.
5. Development of convergence in correct proportion of its two components, voluntary and involuntary convergence.
6. Refinement of binocular fixation and development of stereoscopic vision.—R. J. B.

READINESS FOR READING ACTIVITY. Betts, E. A., Pennsylvania Optometrist, 1941, 10, 2, 6-7.

Reading is a thinking process which requires specialized types of integrated action. It is a dynamic rather than a static process requiring constant changes in or reintegration of patterns of behavior. It requires a high degree of mental, emotional and probably physiological maturity. According to Betts, reading calls for (1) specialized types of thinking processes; hence, a certain degree of mental maturity is essential to success with reading activities. Reading also (2) necessitates taking experience to, as well as drawing it from, the printed page; therefore, a background of pertinent experiences is one prerequisite to achievement. Reading also (3) is in part an interpretative process, and it is for this reason that one is really reading when understanding is gained from facial expressions, pictures, charts, graphs, diagrams, and blue prints, as well as from word symbols on signs and in books. Reading also (4) deals primarily with meanings, not with forms; therefore the mechanics of visual and auditory discrimination rank well down the scale of relative values. Reading also (5) is experiencing, not memorizing; therefore, the learner must develop the ability to apply or relate pertinent past experiences and in many instances to arrive at new ideas and concepts on the basis of the past. Reading also is (6) a process which calls for integrated action. As such, it is more than the sum-total of eye movements, visual perception, selecting and using pertinent experiences, perceiving relationships, and the like, because the mental, emotional and physical responses must be patterned into a purposeful and satisfying total reaction. Reading is (7) a process, not a subject, and (8) reading situations vary with the purpose or

motive of the reading; therefore an efficient reader must be versatile in adapting his habits to meet the needs of a given situation.

According to Betts, reading readiness is a term commonly used to denote a general mental, emotional and physical preparedness for reading activities. He adds, however, that while reading and seeing are somewhat similar inasmuch as both are primarily central processes, it is quite beside the point to predict reading ability on the basis of certain tests having to do with seeing. The author stresses the point that while reading difficulties can be corrected, it is more important that they be prevented.—C. C. K.

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6. OCULAR AND GENERAL PATHOLOGY.

EMBOLISM OF THE CENTRAL RETINAL ARTERY, Lopez, R. B., Optical Journal and Review of Optometry, 1941, LXXVIII, 17, 16-17.

Lopez describes the anatomical and physiologic concepts encountered in cases of embolism of the central retinal artery. He then presents a case report of the condition in which the symptoms, fundus picture and treatment are outlined in detail. He stresses the need for accuracy in diagnosis if these cases are to be assisted. Lopez is an optometrist connected with the Out-Patient Department of the Waterbury (Conn.) Hospital.—C. C. K.

RIGHT HOMONYMOUS HEMIANOPSIA. Gammage, F. V., Eye, Ear, Nose and Throat Monthly, 1941, 20 (June), 137-138.

This case report consists of a study from the otologico-opththalmologic standpoint of the effects of the removal of a glioma from the left parieto-occipital area of the cerebrum. The damage to the brain has produced right homonymous hemianopsia. The anatomy and physiology is described and the symptoms are explained.—R. J. B.

GLAUCOMA. Spitzer, E., Canadian Journal of Optometry, 1941, 3, 2, 44-49.

The diagnosis and treatment of primary glaucoma is reviewed from the standpoint of each of the tissues and media of the eye. Emphasis

is placed on early diagnostic signs. The author, a physician, also makes a plea for greater cooperation between optometrists and eye physicians as the first and most important step in checking this form of ocular pathology.—C. C. K.

NON-SURGICAL TREATMENT OF CATARACT. Biddle, S. G., Optical Journal and Review of Optometry, 1941, LXXVIII, 10, 20-22.

Biddle reviews the therapeutic treatment of cataract, outlining the procedure followed by physicians in the use of dionin, Week's solution, thyroxin, subconjunctival injections of mercuric cyanid in various strengths, as well as potassium iodid and sodium iodid, and also lens antigen. Biddle also mentions vitamin and mineral therapy, diathermy, body radiation with quartz light, color therapy and endocrine therapy as aids in certain cataract cases and suggests that all incipient cases of cataract should be treated.—C. C. K.

MONOCULAR DIPLOPIA. Report of a Case. Pincus, M. H., American Journal of Ophthalmology, 1941, 24, 503-506.

A case is described where the patient, shortly after enucleation of the right eye, becomes conscious of seeing double images with his left eye, and of a scotoma temporal to his point of fixation (which is his "blind spot"). The patient has been under observation for four years and, so far, no reasonable cause has been established to explain his condition. Pincus then outlines the most commonly accepted causes for monocular diplopia as follows: A. Corneal pathology: (1) irregular corneal astigmatism; (2) high degree of corneal astigmatism; (3) parenchymatous keratitis. B. Double pupil (only if the accommodation is relaxed), whether: (1) traumatic; (2) inflammatory; or (3) developmental. C. Lens pathology: (1) irregular lenticular astigmatism; (2) developing cataract; (3) partial dislocation of the lens in the pupillary area: (a) traumatic, (b) developmental; (4) fluid cleft (traumatic). D. Vitreous pathology: (1) opacities: (a) unabsorbed hemorrhage, (b) cysts (echinococcus, and others), (c) salt crystals (cholesterin, and others); (2) foreign bodies: (a) air bubble, (b) droplet of oil, (c) glass. E. Retinal pathology: (1) macular pathology (cyst); (2) retinal detachment. F. Intracranial pathology: (1) encephalitis lethargica: (2)

postencephalitis; (3) multiple sclerosis; (4) basilar meningitis; (5) cerebellar tumors. G. Endocrine pathology: (1) menopause. H. Psychopathology: (1) hysteria. I. Simulation (malingering). "Monocular diplopia may therefore result from pathological changes in any part of the mechanism of 'seeing'."—R. J. B.

A SCOTOMA ASSOCIATED WITH MENSTRUATION. Evans, J. N., American Journal of Ophthalmology, 1941, 24, 507-518.

A scotoma apparently associated with the menstrual period is described. This scotoma is demonstrated by the technique advocated for angioscotometry. It is wedge-shaped, with its apex at the blind spot and its base located peripherally. It responds to the influence of gravity and may show transient fluctuations produced by various influences such as digital pressure on the eyeball. Its greatest bulk occupies the upper field, above a horizontal line 10 degrees above the fixation point. Its area and shape change with various phases of the menstrual cycle. Slight variations occur during the intermenstrual period, but two or three days before the appearance of the flow, an area of blindness (under the conditions of angioscotometry) suddenly appears and rapidly increases to a wavering plateau. Then, a day or two before the menstrual flow ceases, it rapidly diminishes to its premenstrual proportions. The defect is modified by the inhalation of oxygen, and is absent during some or all stages of uncomplicated pregnancy.—R. J. B.

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7. OPHTHALMIC LENSES AND MATERIAL.

VALUE OF ABSORPTIVE LENSES IN ANISOMETROPIA. Vandegrift, G. W., Eye, Ear, Nose and Throat Monthly, 1940, 19, 4, 116-117.

Vandegrift discusses the severity of various anisometropic symptoms and comes to the conclusion that anisometropic cases can be given greater comfort by having their refractive corrections made up in the lighter shades of ophthalmic absorption glass.—C. C. K.

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8. INSTRUMENTS.

RETINAL STUDIES IMPROVED WITH MONOCHROMATIC LIGHT. Poser, M., Iowa Optometrist, 1940, 17, 5, 5.

A new red-free mercury arc lamp to be used in conjunction with the binocular ophthalmoscope is described. The new lamp radiates light in the green and yellow portions of the spectrum along with intense violet lines. This lamp produces a near monochromatic light which, according to Poser, greatly enhances detail in viewing the retina.—C. C. K.

A NEW DARK ADAPTATION TESTER. Yudkin, S. British Journal of Ophthalmology, 1941, 25, 231-236.

The new instrument devised by R. T. M. Haines for measuring dark adaptation is described. Its method of use and advantages over other instruments are discussed. The normal range of dark adaptation is given. A rapid method for surveying large groups is appended.—R. J. B.

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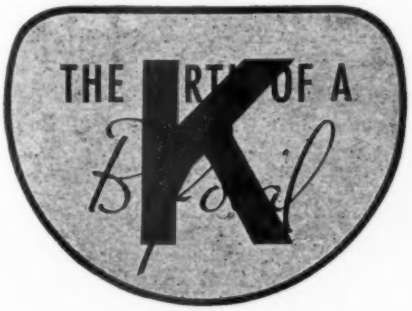

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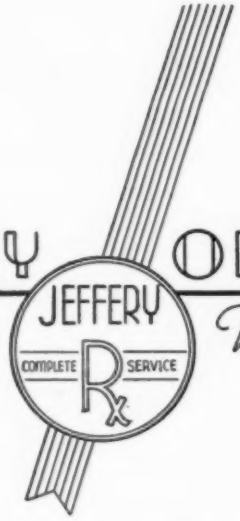

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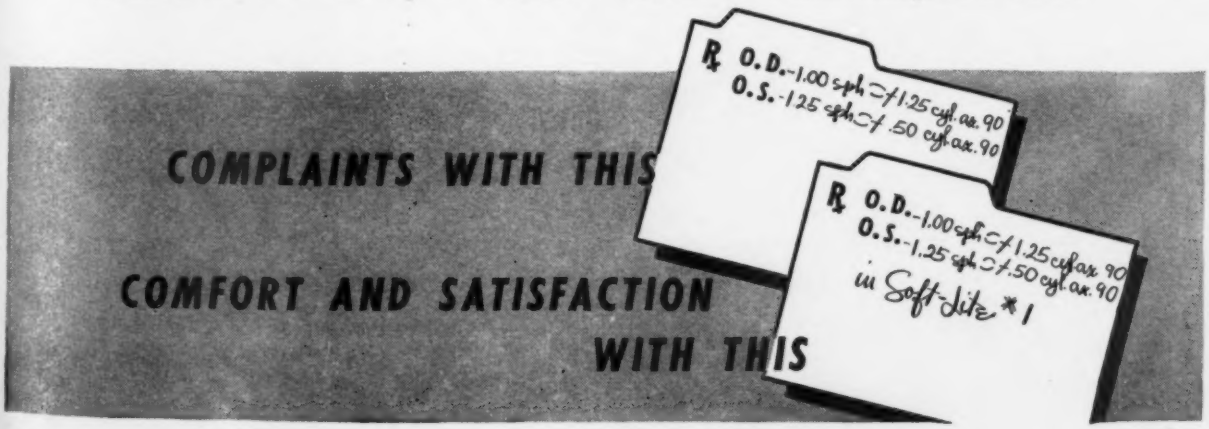
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